MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

PME0016 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

21 OCTOBER 2016
3.00 P.M – 5.00 P.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FIVE** printed pages, excluding the cover page, Appendix I and Appendix II, with **FIVE** questions.
2. Answer **ALL** questions. The distribution of the marks for each question is given.
3. Write all your answers in the Answer Booklet provided.
4. All necessary workings **MUST** be shown.

ANSWER ALL QUESTIONS

QUESTION 1 (10 Marks)

a) i) Provide the meaning of torque. Draw a simple diagram to show how you can calculate the torque of a force and write the related equation.

[3 marks]

ii) Under what conditions are torques positive and negative?

[2 marks]

b) A uniform, 150-N pipe is used as a lever, as shown in Figure Q1. Find x (in terms of L) if a 610 N weight at the right end is to balance a 270 N weight at the left end. What is the reaction force exerted by the support (fulcrum) on the pipe? Draw the free body diagram for the pipe.

[5 marks]

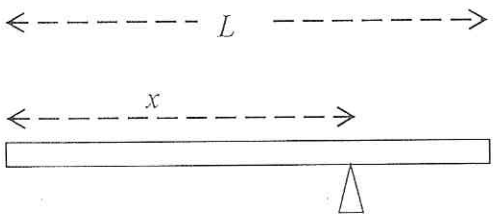

Figure Q1

Continued...

QUESTION 2 (10 Marks)

a) You have graduated from college and now design roller coaster for a living. Your boss asks you to design a roller coaster that is supposed to release a car from rest at the top of a hill of a height h and then roll freely down the hill and reach the peak of the next hill of height $1.1h$. From the principle of conservation of mechanical energy, explain to your boss either it will be possible or impossible to design such roller coaster.

[3.5 marks]

b) A 58 kg skier is coasting down a 25° slope as shown in **Figure Q2(b)**. Near the top of the slope, her speed is 3.6 m/s. She accelerates down the slope because of the gravitational force, even though a kinetic frictional force of magnitude 71 N opposes her motion. Ignoring air resistance, determine the speed at a point that is displaced 57 m downhill.

[6.5 marks]

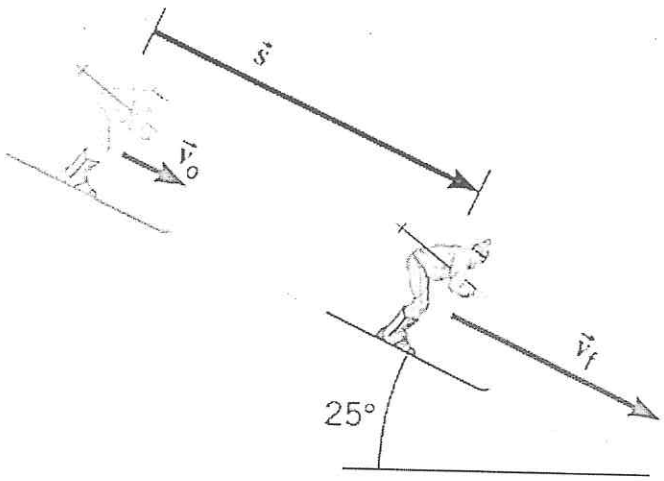

Figure Q2(b)

Continued...

QUESTION 3 (10 Marks)

A circular iron disc having moment of inertia of 10 kgm^2 rotates at an angular velocity of 8π rad/s. After 10 seconds, its angular velocity reduces to π rad/s. Determine

i) the angular acceleration of the disc, [2 marks]

ii) the time taken for the disc to stop, [2 marks]

iii) the total angular displacement when the disc rotates at 8π rad/s until it stops, [2 marks]

iv) the net torque acting on the disc, [1 mark]

v) the net work acting on the disc, and [1 mark]

vi) the change in rotational kinetic energy of the disc from 8π rad/s until it stops. [2 marks]

Continued...

QUESTION 4 (10 Marks)

a) **Figure Q 4(a)** shows graph of force against elongation of a typical steel wire. State briefly the points labelled with A, B and C. (3 marks)

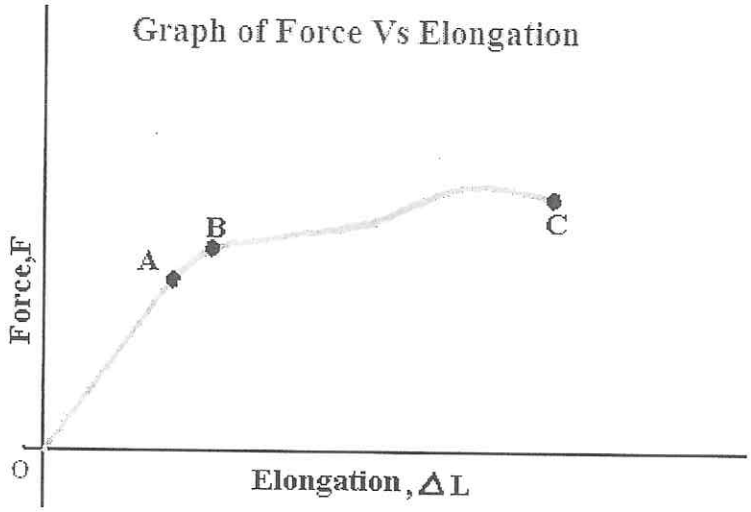

Figure Q 4(a)

b) **Figure Q4(b)** shows five immiscible liquids which are in equilibrium in a U-tube. Liquids '*a*', '*b*', 'c', 'd' and 'e' have densities of 0.806×10^3 kgm^{-3}, 0.879×10^3 kgm^{-3}, 0.925×10^3 kgm^{-3}, 13.6×10^3 kgm^{-3} and 1.000×10^3 kgm^{-3} respectively.

i) Find the height of liquid 'a'.

ii) If the whole U-tube and the liquids are brought to the Moon with lower gravitational acceleration, what will be the changes (if any) to the height in part (i) ?

[4 marks]

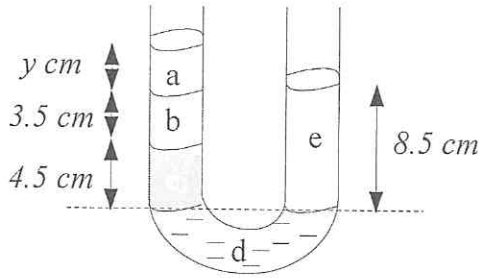

Figure Q4(b)

c) i) State Archimedes' principle.

ii) Give two applications of Archimedes' principle in daily life.

[3 marks]

Continued...

QUESTION 5 (10 Marks)

A spring stretches 0.150 m when a 0.300 kg mass is gently suspended from it. The spring is then set up horizontally with the 0.300 kg mass resting on a frictionless table as in **Figure Q5**. The mass is pulled so that the spring is stretched 0.100 m from the equilibrium point, and released from rest. Determine

a) the spring stiffness constant k

[2 marks]

b) the amplitude of the horizontal oscillation A

[1 mark]

c) the magnitude of the maximum velocity v_{max}

[3 marks]

d) the magnitude of the velocity v when the mass is 0.050 m from equilibrium

[2 marks]

e) the magnitude of the maximum acceleration a_{max} of the mass.

[2 marks]

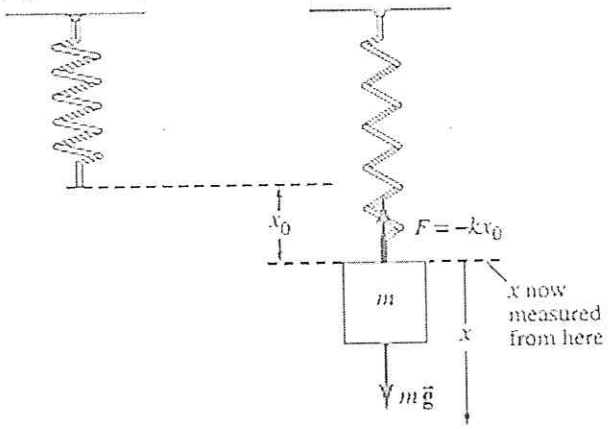

Figure Q5

End of Paper.

APPENDIX I:

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/ mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_0}$	=	9.0×10^9 N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

APPENDIX II:

LIST OF FORMULAS IN MECHANICS

$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$	$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$	$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $\quad y - y_o = v_o t + \frac{1}{2} g t^2$ $\quad v^2 = v_o^2 + 2g(y - y_o)$

$y - y_o = \left(\frac{v_o + v}{2}\right) t$

$a_c = \frac{v^2}{r}$ $\quad F_g = G\frac{m_1 m_2}{r^2}$ $\quad U_g = -G\frac{m_1 m_2}{r}$ $\quad T^2 = K_s r^3$

$\tau = r \times F$ $\quad \sum \tau = \tau_{net} = I\alpha$ $\quad I = \sum mr^2$ $\quad v = r\omega$

$L = r \times p = I\omega$ $\quad K = \frac{1}{2} I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $\quad T_p = 2\pi\sqrt{\frac{l}{g}}$ $\quad T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $\quad x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\quad v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $\quad a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $\quad a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $\quad x - x_o = v_o t + \frac{1}{2} a t^2$ $\quad v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right) t$

$W = mg$ $\quad \sum F = F_{net} = ma$ $\quad f_s \le \mu_S F_N$ $\quad f_k = \mu_K F_N$

$p = mv$ $\quad \sum F = \frac{\Delta p}{\Delta t}$

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$ $\quad m_1 u_1 + m_2 u_2 = (m_1 + m_2)\, v$

$P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2} m v^2$ $\quad PE_s = \frac{1}{2} k x^2$ $\quad F_s = -kx$ $\quad PE_G = mgy$